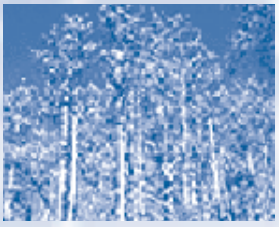
CLIMATE LEADERS GREENHOUSE GAS INVENTORY PROTOCOL

CORE MODULE GUIDANCE

Direct HFC and PFC Emissions from Manufacturing Refrigeration and Air Conditioning Units



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This Guidance is based on the World Resources Institute and the World Business Council for Sustainable Development's GHG Protocol Initiative

CLIMATE LEADERS
U.S. Environmental Protection Agency

The Climate Leaders Greenhouse Gas Inventory Protocol is based on the Greenhouse Gas Protocol (GHG Protocol) developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). The GHG Protocol consists of corporate accounting and reporting standards and separate calculation tools. The Climate Leaders Greenhouse Gas Inventory Protocol is an effort by EPA to enhance the GHG Protocol to fit more precisely what is needed for Climate Leaders. The Climate Leaders Greenhouse Gas Protocol consists of the following components:

- Design Principles Guidance
- Core Modules Guidance
- Optional Modules Guidance
- Reporting Requirements

All changes and additions to the GHG Protocol made by Climate Leaders are summarized in the Climate Leaders Greenhouse Gas Inventory Protocol Design Principles Guidance.

For more information regarding the Climate Leaders Program, e-mail climateleaders@epa.gov

Or visit us on the web at www.epa.gov/climateleaders

Introduction

Historically, air conditioning and refrigeration equipment utilized various Ozone Depleting Substances (ODSs), primarily CFCs and HCFCs. However, in accordance with the Clean Air Act Amendments of 1990 (Title VI) and the Montreal Protocol, these ODSs are being phased out of manufacture and use in the United States. In the refrigeration sector, HFCs and, to a lesser extent, PFCs are used as substitutes for the regulated ODSs.

HFC emissions from the refrigeration and air conditioning sector result from the manufacturing process, from leakage over the operational life of the equipment, and from disposal at the end of the useful life of the equipment. These gases have 100-year global warming potentials (GWP), which are 140 to 11,700 times that of carbon dioxide, so their potential impact on climate change can be significant (Table 1). By the same token, any reductions of these gases can have a large potential benefit.

1.1. Categories of Emissions Covered by this Guidance

This guidance deals with the emissions resulting from manufacturing refrigeration and air conditioning equipment. A Climate Leaders Partner that is in this industrial sector would first define their inventory boundaries per guidance in the *Climate Leaders Design Principles.* A Partner might have a wide range of emission categories based on their inventory boundaries including; stationary combus-

Table 1: Global Warming Potentials

Common Name	Formula	Chemical Name	GWP*
HFC-23	CHF_3	trifluoromethane	11,700
HFC-32	CH_2F_2	1,2-difluoromethane	650
HFC-125	C_2HF_5	pentafluoroethane	2,800
HFC-134a	$C_2H_2F_4$	1,1,1,2-tetrafluoroethane	1,300
HFC-143a	$C_2H_3F_3$	1,1,1-trifluoroethane	3,800
HFC-152a	$C_2H_4F_2$	1,1-difluoroethane	140
HFC-236fa	$C_3H_2F_6$	1,1,1,3,3,3-hexafluoropropane	6,300
PFC-116	C_2F_6	hexafluoroethane (perfluoroethane)	9,200
PFC-14	CF_4	tetrafluoromethane (perfluromethane)	6,500

* Global Warming Potentials from Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (1995). GWP of carbon dioxide is 1.

tion, purchased electricity, mobile sources, etc. These emission categories are not all unique to companies manufacturing refrigeration or air conditioning equipment and a Partner company would estimate emissions from them using the Climate Leaders Core Module Guidance for those specific categories of emissions.

However, during the manufacture of refrigeration and air conditioning equipment there is the potential for release of HFC and PFC gases used to charge the equipment. Emissions may result from small leaks occurring over time during storage, catastrophic leaks, or releases from equipment during charging or repairing. This guidance covers those emissions. Table 2 lists the different categories of emissions from manufacture of refrigeration and air conditioning equipment and the corresponding guidance for accounting for these emissions under the Climate Leaders program.

Under the Climate Leaders reporting approach, Partners that manufacture refrigeration and air conditioning equipment are only responsible for emissions that result at their facilities. Partners are not responsible for emissions that occur during the use of the equipment they manufacture or from the handling of gas sent off site to a third party for recycling or disposal[1].

1.2. Gases Included

Refrigerants include a number of different compounds including CFCs, HCFCs, HFCs, and PFCs, all of which have global warming potentials. As mentioned, CFCs and HCFCs are being phased out of production due to their ozone depleting properties. However, some entities still use CFCs and HCFCs directly or in refrigerant blends.

It is customary to exclude CFCs and HCFCs from greenhouse gas (GHG) inventories because they are regulated and soon to be eliminated by the Clean Air Act and also because their global warming potentials are complicated by the fact that they reduce

Table 2: Categories of Emissions from Refrigeration and AC Equipment Manufacturing

Category of Emissions	Treatment in Climate Leaders
HFC and PFC emissions from refrigeration/AC equipment mfg.	**Refrigeration/AC Guidance** Reported using this guidance.
Emissions from purchased electricity/steam	**Purchased Electricity Guidance** Reported using *Core Module Guidance for Indirect Emissions from Purchases/Sales of Electricity and Steam.*
Emissions from combustion of fossil fuels (e.g., on-site boilers)	**Stationary Combustion Guidance** Reported using *Core Module Guidance for Direct Emissions from Stationary Combustion Sources.*
Emissions from mobile sources	**Mobile Source Guidance** Reported using *Core Module Guidance for Direct Emissions from Mobile Sources.*

1 Refer to the appropriate regulations regarding proper disposal of refrigerants.

ozone, which is also a greenhouse gas. Climate Leaders allows for reporting of CFCs and HCFCs as memo items on a Partner's inventory. They are reported as total releases of gases, but no global warming potentials are applied and these emissions do not contribute to a Partner's total CO_2-Equivalent emissions inventory. Therefore, Partners that currently use CFCs or HCFCs and switch to HFCs or PFCs will show an increase in their overall GHG emissions inventory. Documenting the use of CFCs and HCFCs will help to explain this increase. In addition, Climate Leaders will consider shifts in CFC and HCFC use to HFCs and PFCs when evaluating a Partner's reduction goal if HFCs or PFCs from refrigerant switching are a significant emission source.

Method for Estimating Emissions

Emissions of HFCs and PFCs from equipment manufacturing are estimated through a material balance analysis. Using the material balance approach, releases of HFCs and PFCs are calculated based on the inventory at the beginning and end of the emissions period, purchases during the emissions period, and equipment charged during the emissions period. The inventory is tracked at the facility by type of refrigerant. Equations 1 and 2 show the basic principle involved in this approach.

Equation 2 should be applied to each type of refrigerant used by the equipment manufacturer to determine emissions of that refrigerant. Calculating emissions with the mass based approach requires the following steps for each type of refrigerant:

Step 1: Calculate the change in inventory. A refrigerant inventory consists of the refrigerant contained in cylinders or other storage but not equipment. The change in inventory is calculated by subtracting the inventory at the end of the reporting period from the inventory at the beginning of the reporting period.

Step 2: Determine purchases and other acquisitions. This includes refrigerant purchased from producers/distributors, refrigerant returned by equipment users, and refrigerant returned after off-site recycling or reclamation.

Step 3: Determine sales/disbursements. This includes refrigerant charged into equipment, refrigerant delivered to customers in containers, refrigerant returned to refrigerant producers, refrigerant sent off-site for recycling or reclamation, and refrigerant sent off-site for destruction.

Step 4: Calculate emissions. Emissions are calculated based on the results of the first three steps using Equation 2.

As mentioned, this approach should be done for each type of refrigerant and refrigerant blend used. Section 3 describes in more detail the type of data that is used in determining emissions.

Equation 1: Material Balance of Refrigerant

$I_B + P = I_E + C + \text{Emissions}$

where:

- I_B = amount of refrigerant in inventory at the beginning of reporting period (storage not equipment)
- I_E = amount of refrigerant in inventory at the end of reporting period (storage not equipment)
- P = amount of refrigerant purchased during the reporting period
- C = amount of refrigerant charged in equipment or otherwise disposed of during the reporting period

Therefore:

Equation 2: Emissions from Refrigerant

Emissions = IB - IE + P - C

Choice of Activity Data

Required data for the material balance method can take the form of inventory records, purchase records, repair reports, service records, and disposal records. Although refrigerant mixtures are used in many different applications, care should be taken to account for either the mixtures (such as R-507A) or the individual HFCs (such as HFC-125). It is recommended that Partners track their refrigerant usage in the same manner as their other records are maintained, which will generally be on a refrigerant mixture basis, unless the Partner mixes refrigerants on-site.

The quantity of refrigerant charged into equipment should not include charging emissions. In other words, it is not necessary to track any refrigerant leaks that may occur during charging as these emissions will be captured under the material mass balance approach. If the equipment is fully charged, the quantity of refrigerant charged into equipment should be the total full charge of the equipment. If the equipment is only partially charged, the quantity of refrigerant charged into equipment should be the mass of refrigerant actually charged into the equipment (if known) or the product of the total full charge and the ratio between the partial filling density and the full filling density. (The ratio of the partial and full pressures may be used instead of the ratio of the partial and full filling densities as long as the pressures are compared at a constant temperature.) Equation 3 outlines the method to determine the amount of refrigerant charged into equipment.

As shown in Section 2, the use of a material balance approach to estimate emissions from the manufacture of refrigeration and air conditioning equipment requires data on the inventory, purchases, and sales of different refrigerants. Specifically, a Partner has to determine the following activity data for each different refrigerant used.

- Refrigerant inventory at beginning of year (in storage, not equipment)
- Refrigerant inventory at end of year (in storage, not equipment)
- Refrigerant purchased from producers or distributors
- Refrigerant returned by equipment users
- Refrigerant returned after off-site recycling or reclamation
- Refrigerant charged into equipment (or alternatively the nameplate capacity and the full and partial density or pressure)
- Refrigerant delivered to equipment users in containers
- Refrigerant returned to refrigerant producers
- Refrigerant sent off-site for recycling, reclamation, or destruction

Equation 3: Refrigerant Charged into Equipment

$$\text{Refrigerant Charged} = \text{Nameplate Capacity} \times \frac{\text{Density or Pressure of Partial Charge}}{\text{Density or Pressure of Full Charge}}$$

Note: If pressure is used it should be provided in absolute units (e.g., Pa or psia).

Completeness

An assessment of emissions from the manufacture of refrigeration or air conditioning equipment must be completed on a corporate as well as a facility level basis. From a corporate perspective, the inventory should include emissions from all types of refrigerants in all facilities owned, partially owned, or leased by the company. This is addressed in Chapters 2 and 3 of the *Climate Leaders Design Principles* that discusses setting the boundaries of the corporate inventory. Completeness of corporate wide emissions can be checked by comparing the list of facilities included in the GHG emissions inventory with those included in other emission's inventories/environmental reporting, financial reporting, etc.

The completeness of activity data should be described, including listing any sources or refrigerants from which emissions were not estimated. As described in Chapter 1 of the *Climate Leaders Design Principles* there is no materiality threshold set for reporting emissions, it is up to the Partner to decide and justify which sources to exclude due to lack of materiality. Therefore, any sources that were excluded from the inventory should be documented and proof given that the excluded emissions are indeed immaterial.

The inventory should also accurately reflect the timeframe of the report. In the case of Climate Leaders, the emissions inventory is reported annually and represents a year of emissions data. Therefore, all refrigerants used during the reporting year should be accounted for in that year's inventory.

Uncertainty Assessment

There is uncertainty associated with all methods of calculating GHG emissions. As outlined in Chapter 9 of the *Climate Leaders Design Principles,* Climate Leaders does not recommend Partners quantify uncertainty as +/- % of emissions estimates or in terms of data quality indicators. The effort spent to perform such analysis would be better spent pursuing high quality inventory data. It is recommended that Partners attempt to identify the areas of uncertainty in their emissions estimates and make an attempt to use the most accurate data possible.

Reporting and Documentation

Partners are required to complete the Climate Leaders *Reporting Requirements* for manufacture of refrigeration/AC equipment and report past year emissions annually. Partners should report the data listed in Table 3 below. In order to ensure that estimates are transparent and verifiable, the documentation sources listed should be collected and maintained by the reporting company.

Table 3: Documentation Sources

Data	Documentation Source
Inventory at Beginning and End of Year	Stock Inventory documentation
Purchases	Purchase receipts; delivery receipts; contract purchase or firm purchase records
Nameplate Capacity of Equipment	Delivery receipts of equipment; records of physical inspection of nameplates; shipping or disposal records of equipment
Amounts Charged to Equipment	Repair records; repair invoices; daily reports
Amounts Recovered from Equipment	Repair records; repair invoices; daily reports; disposal records

Inventory Quality Assurance and Quality Control (QA/QC)

Chapter 9 of the *Climate Leader Design Principles* provides general guidelines for implementing a QA/QC process for all emission estimates. For manufacturing refrigeration and AC equipment the following items must be addressed:

- Care should be taken that releases are not double-counted (e.g., from reporting both refrigerant blend and individual blend component use).
- Verify that your inventory is complete. Because the GWP of HFCs and PFCs are so large (particularly when compared to carbon dioxide and methane), failure to account for even relatively small releases of HFCs and PFCs can make a big difference when the releases are converted to a CO_2 equivalent basis. Also, tracking each HFC and PFC used separately is important, because of the differing GWPs.

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